A Suspension Trailing Arm

The present invention relates to a suspension trailing arm and a method of making a suspension trailing arm. More particularly, the present invention relates to a cast or forged suspension trailing arm, a suspension assembly incorporating a trailing arm and method of securing an axle locating feature of a suspension trailing arm to an axle.

Heavy commercial vehicles typically employ trailing arm suspension systems, particularly in relation to the axles of trailers of articulated vehicles or potentially rear axles of rigid body vehicles.

Heavy commercial vehicles (including trucks, buses and coaches) can be distinguished from light commercial vehicles (such as vans) and light passenger vehicles due to one or more of the following characteristics:

1. A laden weight in excess of approximately 3.5 tonnes.
2. The use of air actuated brakes as opposed to hydraulically actuated brakes (because air actuated brakes are more able to withstand the increased heat generated by the repeated braking of a vehicle having a weight in excess of approximately 3.5 tonnes).

Such vehicles (including trailers) also typically employ a pair of spaced parallel beams that run the length of the vehicle and act as the chassis upon which the vehicle body is mounted.

When used in heavy commercial vehicles the trailing arms are typically pivotally mounted to the chassis beams of the vehicle at the front of the arm, the arm extending rearwardly (i.e. towards the rear of the vehicle) to a mounting position for the axle and then further rearwardly to a mounting surface for an air spring, that is itself mounted between the trailing arm and vehicle chassis. Axles in such vehicles are typically substantially rigid beam-type axles (i.e. axles that extend between the spindles upon which wheels at opposite sides of a vehicle are mounted). In some circumstances the orientation of the arms may be reversed so as to pivot at the rear of the arm, in which case they are known as "leading arms". For the purposes of this specification the term trailing arm should also be understood to encompass leading arms.

Known heavy vehicle trailing arms are typically constructed either from solid spring steel trailing arms provided with U-bolts and plates to connect an axle to the arm, fabricated steel plate which is then welded to an axle or axle adapter, or a hybrid of the two aforesaid types. An example of a fabricated trailing arm is disclosed in US5639110 (Pierce et al.). Both prior art types seek to provide a rigid connection between the arm and axle in order to resist bending but have a resilient connection between the chassis and axle, either by flexing of the spring steel trailing arm or by flexing of a large elastomeric bush (resilient bearing) in the end of a fabricated trailing arm. This enables articulation forces induced during vehicle use to be taken up whilst maintaining tracking and roll stability. It has typically been considered necessary in the case of fabricated trailing arms for use in heavy commercial vehicle applications for these to be manufactured having a closed box-section profile in order to impart sufficient strength to the arm to withstand vertical bending forces, as well forces caused by cornering, vehicle roll and travel over uneven surfaces.

Two prime disadvantages have been identified in known trailing arm designs. Firstly, the known manufacturing techniques often place restrictions on the shape of the trailing arm, which in turn restricts the positioning of additional components that are mounted to the arms, such as brakes, air springs, dampers and pivot bushes. This may lead to the suspension packaging (i.e. its space requirement) being inefficient. Secondly, known types of trailing arm designs are time consuming and hence expensive to manufacture, either due to the welding or fastening of the various components that constitute the trailing arm together, or the fastening or welding operations required to secure the trailing arm to an axle.

It is known from US5203585 (Pierce) to make a cast trailing arm type suspension for heavy vehicles. However, a separate subassembly is provided to mount the axle to the arm.

The present invention seeks to overcome, or at least mitigate the problems of the prior art.

Accordingly, a first aspect of the present invention provides a cast or forged suspension trailing arm for suspending a heavy vehicle chassis from a beam-type axle, the trailing arm comprising an integral axle locating feature.

.A second aspect of the present invention provides a suspension assembly comprising an axle and a first trailing arm, the first arm comprising an axle locating feature having first and second axle wrap portions, the wrap portions encircling the axle and having complementary circumferential mating faces, the faces being welded together such that no welding of the locating feature to the axle occurs at the mating faces.

A third aspect of the present invention provides a method of securing an axle locating feature of a suspension trailing arm to an axle, the locating feature comprising first and second axle wrap portions the method comprising the steps of: i)offering up the first and second axle wrap portions to the axle such that the axle is encircled; ii) securing the axle wrap portions to the axle.

A fourth aspect of the present invention provides a cast or forged suspension trailing arm for suspending a chassis from a beam-type axle of a heavy commercial vehicle further comprising a bracket for the mounting of a brake, or a brake part.

Embodiments of the present invention are now described, by way of example only, with reference to the accompanying drawings in which:

FIGURE 1 is a side view of a typical heavy commercial vehicle;

FIGURE 2 is a perspective view of a prior art suspension assembly;

FIGURE 3 is a perspective view of another prior art suspension trailing arm;

FIGURES 4A and 4B are perspective views of a suspension trailing arm according to a first embodiment of the present invention;

FIGURES 5A to 5C are perspective views illustrating the assembly of a suspension trailing arm according to a second embodiment of the present invention;

FIGURES 6 and 7 are perspective views of a suspension assembly incorporating a suspension arm according to a third embodiment of the present invention;

FIGURES 8 to 10 are perspective views of a suspension trailing arm according to a fourth embodiment of the present invention;

FIGURES 11 to 13 are perspective views of a rear portion for attachment to the arm of Figures 8 to 10;FIGURES 14 and 15 are perspective views of two arms of Figures 8 to 10 secured to an axle;

FIGURE 16 is a perspective view of the arms of Figures 14 and 15 with the rear portions of Figures 11, 12 and 13 secured thereto;

FIGURE 17 is a perspective view of a suspension assembly comprising the arm of Figures 8 to 10; and

FIGURE 18 is a perspective view of a suspension assembly incorporating a trailing arm according to a fifth embodiment of the present invention.

FIGURES 19, 20, 21, 22 and 23 are side, plan, underside, front end and rear end views respectively of an arm according to a sixth embodiment of the present invention.

FIGURE 24 is a detail view of the mating edges of the front and rear portions of the axle wrap of the arm of the sixth embodiment.

FIGURES 24A and 24B are detail cross-sectional views of the transverse and opening edge welds respectively, of the sixth embodiment.

FIGURE 25 is a side view of an alternative rear portion for use with the front portion of the sixth embodiment in top mount applications.

Figure 1 shows a heavy commercial vehicle 20 comprising a tractor portion 22 and a trailer portion 24 mounted for articulation relative to the tractor portion. A plurality of wheels 26 are suspended from a chassis 25 of the trailer portion so that the wheels rotate about axes 28.

Turning to Figure 2 in which a prior art suspension assembly 30 is shown, this briefly comprises a spring steel suspension arm 32, a chassis support bracket 34 and an air spring 36. The support bracket 34 and air spring 36 provide a connection with, and suspension relative to, the trailer chassis 25 (shown in broken lines for clarity) in a known manner. U-bolts 40 and top and bottom plates 41a and 41b provide a means of mounting an axle 42 (shown in broken lines for clarity) to the trailing arm 32. In particular it should be noted that bottom plate 41b is welded directly to axle 42. Wheels (not shown) are secured to each end of the axle 42 for rotation about axis 28. A

damper 44 mounted between support bracket 44 and U-bolt and plate assembly 40 is provided to damp oscillations of the axle 44 relative to the chassis 25 as the vehicle 20 drives over uneven ground.

A fabricated steel trailing arm 132 of a prior art design is shown in Figure 3 and comprises a bush 146 housing a resilient bearing (not shown) to enable the arm to be mounted to a chassis support bracket and an integrated axle wrap 148 to support axle 42 of the vehicle 20. The axle wrap 148 is first welded to the axle 42 around the periphery of openings 149 (only one visible in Figure 3, but two are present on the wrap 148) and the remainder of the arm is then welded to the axle wrap. The arm 132 is further provided with a surface 150 upon which an air spring (not shown) may be mounted.

It will be appreciated that for both types of prior art trailing arm described above, a considerable amount of assembly is required and a large number of components are needed to provide a complete suspension assembly.

Turning to Figures 4A and 4B, these show a trailing arm 232 according to a first embodiment of the present invention to which a conventional beam-type axle 42 is mounted (Figure 4A only). Such axles are typically capable of each carrying 6 or more tonnes of payload in use. The trailing arm 232 is cast as a single piece, having a front portion 252 and a rear portion 254 separated by an axle locating portion or feature in the form of a cast axle wrap 256 dimensioned to receive the axle 42 therethrough.

The leading end of the front portion 252 is cast so as to provide a bearing mounting 246 to receive a resilient bearing (not shown) that mounts the trailing arm 232 to a chassis support bracket (not shown) in a similar manner to the prior art.

Intermediate the axle wrap 256 and bearing mounting 246, the front portion 252 is cast with an I-section profile to provide an optimum strength to weight ratio for the arm 232.

The rear portion 254 is provided with an upwardly facing substantially planar surface 250 upon which an air spring (not shown) may be received. Through holes 251 may further be provided on surface 250 in order to securely locate the air spring on the surface by the use of bolts therethrough, for example. A downwardly extending web 253 may be provided therein so to form a shallow T-section and impart sufficient strength to this portion of the arm 232. In other embodiments the rear portion 254 may be an I-section or box section, for example.

Openings 258 are preferably provided in the cast wall that constitutes the axle wrap 256. The openings enable the axle 42 to be securely ring or fillet welded to the trailing arm 232 around the edge of the openings 258 to ensure a secure connection between the two components. A similar opening 259 is provided on the opposite side of the wrap 256 for a similar purpose.

The arm 232 may be made using any suitable casting or forging process and may be cast or forged from any suitable material having sufficient strength and durability properties for this particular application, such as cast iron or cast steel. One advantage of cast steel is that the weldability of the arm is improved. In some embodiments surfaces of the arm 232 are machined to provide a suitable surface finish for fitment to the axle or other components, or to remove any stress raising surface contours.

Referring to Figures 5A to 5C, a second embodiment of the present invention is illustrated in which like parts have been designated where possible by like numerals with respect to Figure 4 but with the prefix “2” being replaced by the prefix "3". Only differences with respect to the trailing arm of the first embodiment will therefore be described in further detail.

It can be seen that in this embodiment the front portion 352 is cast as a separate piece from the rear portion 354. Thus, the axle wrap is constituted from two separate portions 356a of front arm portion 352 and 356b of rear arm portion 354. As in the first embodiment, openings or windows 358 and 359 are provided. The openings 358 and 359 permit each wrap portion 356a and 356b to be independently plug welded to the axle 42. It can be seen that in Figure 5B front arm portion 352 is first welded to the axle 42, this is subsequently followed by the rear arm portion 354. However, in alternative embodiments the rear portion is welded on first, or both the front and rear portions 352 and 354 are welded directly to each other along mating edges 360 prior to being welded to the axle. These edges 360 may be angled so as to provide a notch (not shown) in which the welding material may solidify. In a preferred embodiment, the front and rear portions are welded together whilst in situ around the axle and the welds are allowed to cool before the arm is welded to the axle via openings 358 and 359. This welding method has been found to improve the durability of the connection between arm and axle. In particular it has been noted that providing the front opening 358 inboard of the web appears to be particularly effective in transmitting torsional loads induced in the axle due to vehicle roll through the wrap and into the arm. It should also be realised that by extending the axle wrap inboard, the contact area of the wrap with the axle may be increased without interfering with the fitment of brakes and the like to

the outboard end of the axle 42. In turn, this increased contact area enables the size of the openings to be increased so that the length of the weld runs around the edges of the openings increases, and so does the strength of the connection.

One advantage of the arm 332 of this embodiment is that it may be simpler to cast in two parts as opposed to a single part. Furthermore, the mating of the two parts around the axle 42 means that it is not necessary to slide the axle through the axle wrap 256 for assembly as is the case with the first embodiment.

Turning now to Figures 6 and 7 a third embodiment of the present invention is illustrated and, as before, like numerals where possible designate like parts, but with the with the prefix “3” being replaced by the prefix "4".

In this embodiment a further variant of trailing arm 432 is illustrated in situ in a suspension assembly 430. The arm 432 is cast as a single piece and is pivoted at its leading end to a chassis support bracket 434 by a bearing (not visible) mounted in housing 446. A damper 444 extends between the bracket 434 and a mounting feature in the form of a mounting hole 485 provided in the front portion 452 of the arm.

Additionally, it can be seen that axle wrap 456 is provided with an extension 362 in a direction outwardly towards the end of the axle and a bracket 464 is cast integrally therewith in a direction radially outwardly from the wrap to enable a carrier portion 466 of a disc brake to be secured thereto by bolts 472. In turn, a floating caliper 468 of the disc brake is mounted to the carrier 466 for movement parallel to axis 28, as is well known. A brake actuator 470 is secured to the caliper 468 and is arranged to float along with the caliper. It should be noted that the lower flange portion 474 of the front portion 452 of the trailing arm has a raised concave lower face portion when viewed from the side to accommodate the actuator 470 and is cut away to accommodate the caliper (when the friction material of the brake is worn), thus optimising the space in the vehicle taken up by the suspension assembly and brake.

It will be appreciated that by providing a bracket 464 for mounting a brake that is cast integrally with the trailing arm 432, the part count and assembly time of the suspension, brake and axle assembly may be reduced, leading to cost savings in the manufacture and assembly of a vehicle 20 to which they are fitted. Additionally the arrangement reduces the number of components that need to be welded directly to the axle, thus potentially increasing its service life. Furthermore, the integration of the various parts

may reduce the unsprung mass of a vehicle leading to improvements in handling and ride comfort.

In a further development of the trailing arm, a brake carrier itself or part of a brake carrier, may be cast integrally with the trailing arm further reducing the part count of the overall assembly.

In other classes of embodiment, the bracket for mounting a brake or brake part may be secured to or formed in suspension trailing arms that are not cast. Rather, the bracket or brake part may be welded or otherwise secured to a fabricated or spring steel arm, or extension thereof. For example, the axle wrap of a fabricated trailing arm may be adapted to include a bracket or brake component.

An arm 532 according to a fourth embodiment of the present invention is shown in Figures 8 and 9 in which like numerals are designated by like parts but with the prefix "4" being replaced with the prefix "5". The arm 532 is similar to that of the first embodiment of Figures 4A and 4B except that a cast rear portion for receiving the air spring is omitted (but the wrap 556 is cast as a single piece, and in that the arm has a C-section profile rather than an I-section).

It should be noted that one advantage of using a C-section profile is that the potential is increased to cut away a greater portion of lower flange 574 in order to permit more travel of a disc brake caliper away from the wheel when the friction material of the brake is worn (because the web is further inboarnd than for I-section profiles). It should be noted that in this embodiment, vertical stiffening members 577 are provided between the lower flange 574 and the upper flange 576 in order to improve the structural integrity of the C-section.

A thickened boss 575 is also cast in the front portion that is drilled through to act as a mounting for a damper (see Figure 17).

It should be noted that whilst the entire axle wrap 556 is cast integrally with the arm, a separate fabricated rear portion 554 as shown in Figures 11 to 13 is provided so as to be welded to the axle wrap 556 once this has been secured to axle 42 by ring or fillet welding openings 558 and 559 (see Figures 15 to 17). It can be seen that the rear portion 254 comprises upper and lower sheet portions 578 and 579 interconnected by spaced side walls 580, thereby forming a curved box section with a surface 550 arranged to receive an air spring 536 (see Figure 20). In alternative embodiments, half

of axle wrap 556 may be cast integrally with the arm, with the other half being attached to the fabricated rear portion 554 as a cast or fabricated half. It should also be appreciated that other forms of fabricated rear portion may be used. For example, bottom plate 579 may be omitted or the portion may be fabricated to form an I or T-section for example.

Turning to Figure 17, one suspension assembly 530 is shown and comprises axle 42, arm 532, mounting bracket 534, a damper 544 mounted between the arm and the bracket, air spring 536, a brake carrier 566 mounted on a bracket 564 (see Figure 16) and to which a caliper 568 and actuator 570 are mounted. It can be seen that the front portion 552 is cranked to provide more space between it and the brake and wheel and that actuator 570 fits within the raised portion of lower flange 574 and that space is provided by the cut out section of lower flange 574 to accommodate the sliding of caliper 568. It can further be seen that a wheel hub 582 is rotatably mounted to the end of axle 42 and that a brake disc or rotor 584 is secured to the hub 582 to be straddled and received by brake caliper 568. It can be seen that the arrangement of the arm 532 provides more space for accommodating the brake caliper 568 and actuator 570 and/or enables a narrower track wheel to be fitted to a vehicle having a standard spacing between the longitudinal chassis members 25.

Figure 18 illustrates a further embodiment of the present invention which is similar to the first embodiment of Figures 4A and 4B except that the surface 650 for receiving the air spring 636 is higher relative to the axle wrap 656 and axis 28 of the axle. This arrangement thus provides a "top mount" layout for the suspension which has a higher ride height for a given air spring compared with the first embodiment.

Figures 19, 20, 21, 22, 23, 24, 24A and 24B illustrate a sixth embodiment of the present invention in which like numerals where possible designate like parts, but with the prefix "7" replacing the prefix "6".

It can be seen that the arm of the sixth embodiment is similar in many respects to that of the second embodiment in that it is formed from separate front and rear sections 752 and 754 that are joined together by transverse welds at edges 760 of front and rear axle wrap portions 756a and 756b.

It can be seen from Figure 20 that both the front and rear axle wrap portions 756a and 756b are locally widened in the axial direction of axle 42 close to edges 760 so that the length of these edges is greater than in the second embodiment. This provides a greater

weld length between each edge surface, thereby providing a stronger join. It also means that the weld between the two edges 760 does not terminate in line with the non-widened part of the inboard and outboard sides 786 and 788 of the wrap portions at a position where the stresses acting on the welds in use may be raised, thus increasing the risk of a failure in the weld. Smooth arcuate transition portions are provided between the widened portions and non-widened portions of the outboard and inboard edges 786 and 788 of the axle wrap portions 756a and 756b.

Referring in particular to Figure 24, one edge-to-edge connection is illustrated in more detail before any welding has occurred, but with both axle wrap portions 756a and 756b offered up to an axle 42. It can be seen that each edge 760 has a particular profile. In this case the profile is formed by casting the arm as a single piece and subsequently machining the wrap portions 756a and 756b to give the required shape of the edges 760. In another embodiment, the front and rear sections of the arm 752 and 754 may be separately cast with the edge shapes already provided therein.

Specifically, and working radially inwards, each edge 760 comprises a substantially planar surface 790 angled between 10° and 50° preferably around 30° to a radius of the wrap. This surface extends approximately 8 mm radially inwardly. A further surface 792 is then provided which extends approximately 1 mm radially inwardly and is substantially parallel to a radius of the wrap. Finally, the innermost portion of the edge comprises undercut 794 that extends circumferentially for approximately 6 mm and terminates in a curved section to provide a smooth transition to the radially innermost face of the wrap. The undercut portion 794 has a depth of approximately 3 mm. The total thickness of the axle wrap portions at this region is therefore less than 20 mm and preferably less than 50 mm. This is particularly advantageous at the top of the arm 732, since it means that the arm may be used in “low mount” or low ride height applications without the arm fouling on the chassis above. The thickness of the wraps 756a and 756b is preferably optimised to provided sufficient strength and stiffness without adding unnecessary weight to the arm 732.

Assembly of the front and rear portion 752 and 754 of the arm 732 around the axle 42 is as follows:

The front and rear axle wrap portion 756a and 756b are offered up to the axle 42. The radius of the axle 42 and of the wrap portions are dimensioned to provide a close fit between the outer face of the axle 42 and the inner faces of the wrap portions 756a and 756b. This may be achieved by machining the surfaces. The external radius of the axle

is ideally substantially identical to the internal radius of the arm (eg both are 126 mm). The tolerance in the radius of each wrap portion is preferably +0.1 mm -0 mm and the tolerance in the radius of the axle is preferably plus 0 mm -0.1 mm. In other words, the axle 42 should not be too large to fit within the axle wrap portions 756a and 756b, although a number of the advantages of the arm to axle connection may still apply if the tolerance is greater. However, the wrap portions 756a and 756b should be dimensioned circumferentially such that there is a gap of approximately 3 mm between the opposing surfaces 792 when the wrap portions are in place around the axle 42. Once the wrap portions have been offered up to the axle 42, a backing strip 796 that is approximately 15 mm wide and 3 mm deep is inserted into the undercut portion 794. The strip 796 is preferably made from a relatively soft metal such as mild steel or a copper alloy and is provided to prevent subsequent welds from fusing the wrap portion 756a and 756b to the axle 42. The backing strip has also been found to improve the integrity of the weld by giving good root fusion.

In other embodiments, the backing strip may be replaced by a lip provided on one of the wrap edges 760 that mate together, or a ceramic coating on the axle, for example.

The welding procedure is as follows:

A "root pass" and first fill pass are carried out along one of the joints between edges 760. Root passes and one or more fill passes are then carried out along the second joint until this is complete. The welding procedure may require as many as five separate passes. A completed transverse weld 797 having five passes is shown in Figure 24A. The remaining weld passes are then completed on the first joint. The welding is preferably carried out using a metal inert gas (MIG) or a metal active gas (MAG) process and a AR20CO_2 shielding gas mixture using a 1.2 mm dia wire. These transverse welds are then allowed to cool naturally, which causes them to contract and pull the front and rear axle wrap portion 756a and 756b more tightly around the axle 42 such that the wrap portions are in tension and the axle is in compression.

The welds around the edge of openings 758 and 759 are then carried out by welding around the entire circumference of each edge in multiple passes (again to 5 separate passes) to weld the openings to the axle. The circumference of each window is prepared such that there is approximately a 90° angle between the intersection of the edge of each window and the axle, and such that there is a close fit between the wrap and the axle around the intersection of the edge. To enhance the durability of the welds, it is preferred that each weld run starts and finishes away from the corners of

each opening 758 and 759. A cross-sectional view through a completed opening edge weld 798 is shown in Figure 24B. It will be appreciated the openings 758 and 759 are located close to the neutral axis of the axle, where bending stresses of the axle, in use, are at their lowest.

It has been found that the welding procedure outlined above gives a particularly high strength and durable connection between the trailing arm and axle when fitted to a vehicle and operated in normal circumstances. In some circumstances, it has been noted that the transverse welding causes the edges 760 of the front and rear wrap portions 756a and 756b to lift clear of the axle by a small amount, which coupled with the close fit of the remainder of the axle wrap, may enhance durability.

It is envisaged that if robotic welding techniques are to be used, the number of passes required at each joint may be reduced significantly, whilst still giving adequate strength to the connection.

It is also believed that the above described wrap to axle connection may enable thinner axle tubes to be used (eg 11 mm rather than 13 mm) to give the required strength for each axle, whilst saving weight. These benefits are thought to have been achieved due to a combination of the positioning of the welds in the wrap, and the wrap being highly rigid and homogeneous, so that it effectively distributes bending stresses and loads from the axle through the arm, and also because the arrangement inhibits the axle bending locally around the welds due to its close fit.

Referring back to figures 19, 20, 21, 22 and 23, the following additional features of the arm may be noted:

The upper and lower flanges 776 and 774 of the front section 752 of the arm are of tapering thickness. That is to say, the upper and lower flanges are thicker closest to the axle wrap portion 756a than they are proximate the bearing mounting 746. This is because the bending stresses in the front section of the arm are greatest closest to the wrap. Additionally, it may be noted that the width of the upper and lower flanges widens towards the front axle wrap portion 756a for similar reasons. To improve the packaging of the arm for accommodating additional components such as brake components the outboard edges 781 and 777 of the upper and lower flanges 776 and 774 are substantially straight and at substantially 90° to the axis of the axle and axle locating feature 28 (except that the lower flange edge has a recess 783 proximate the axle wrap portion 756a to accommodate a portion of the brake). It should also be noted

that at the intersection of the front portion of the arm 752 and the axle wrap portion 756a, there is a smooth transition such that forces generated in the wrap may be transmitted smoothly to the arm without any stress raising locations being created.

Additionally, as in a number of the preceding embodiments, the lower flange 774 has a concave curved profile proximate the axle wrap portion 756a to accommodate an air actuator of a disc brake assembly.

Due to the asymmetric nature of the front section of the arm 752, the web is offset from the middle of the flanges 776 and 774 in an inboard direction at the point it intersects with the bearing mounting 746, but it intersects at 90 ° to the front wrap portion 756a and bearing mounting.

The front portion also comprises a thickened boss portion 775 that is drilled through to enable a fastener of a damper or shock absorber (not shown) to be fitted therethrough. The relative locations of the through bore 785 and the lower flange 774 may be such that the head of a fastener may be prevented from rotating when inserted into the hole due to contact with the flange, thus making fitting of a damper somewhat easier. In other embodiments, the top flange may be provided with an integral damper mounting so that the damper may be mounted above and in line with the arm 732, or a separate mounting may be secured thereto.

It can be seen from Figures 19 and 21 in particular that the rear section 754 of the trailing arm of this embodiment has a tapered unequal I-section profile comprising a relatively wider upper flange 755 and relatively narrower lower flange 757 with the web 754 therebetween. In this embodiment, the thickness of the flanges 755 and 757, and the depth of web 753 progressively decrease with increasing distance from the rear axle wrap proportion 756b. The lower flange 757 is provided with a concave recess portion 759 to accommodate part of a disc brake (not shown), although this may not be necessary in other embodiments. It can also be seen that the rear section extends relatively steeply downwards from the axle wrap before levelling off at the air spring mounting surface 750. This configuration enables the trailing arm to be used in "low mount" or low ride height applications. This ability is further enhanced by the minimal depth of the arm (less than 20 mm) above the axle, so that use of the arm in low mount applications is not prevented by the arm fouling on the chassis of the trailer 25 at maximum suspension travel. The air spring mounting surface is arranged so as to be substantially in line with outboard opening 758 in rear axle wrap 756b

Figure 25 illustrates an alternative rear portion of the arm 854 which is shaped such that the mounting surface 850 for the air spring is higher relative to the axle locating portion than the rear section of the embodiment of Figure 19. As the lower flange 857 does not extend as low as flange 757, it is not necessary to provide a recess 759 therein. It should be noted that rear portion 854 may be interchanged with rear portion 754 without any adaptation been required to the front portion 752 of the sixth embodiment.

It will be appreciated that the arm (not shown) provided for the opposite side of a vehicle is asymmetric with the arm described above and is essentially a mirror image of that shown in Figures 19 to 25, in order that the various features of the arm 732 may be provided in appropriate locations. However, it should be noted that the rear sections 754, 854 may be interchanged between opposite sides of a vehicle so that the air spring mounting surface 750, 850 is moved inboard to allow more clearance for vehicle wheels. This is particularly applicable when the arm is to be used with dual-wheel type vehicles.

Although the forgoing description has been in relation solely to cast trailing arms having C- or I-section profiles, it is envisaged that these and other open section profiles (eg T-section) profiles may have advantages when employed in relation to fabricated or other types of trailing arm. Such profiles would require a web and at least one flange to impart sufficient strength to the arm. However, the location of the web further inboard in relation to the end of an axle to which the arm is secured in comparison with box-sections provides more room for the fitment of other components, specifically braking components. This is particularly the case if a portion of the lower flange is cut away. Furthermore, whilst such profiles provide sufficient tracking stability (i.e. are sufficiently resistant to lateral forces induced during cornering), they may be more compliant torsionally along their length. This means that smaller resilient bearings may be required to accommodate such torsional loads.

It should be understood that terms such as front, rear, top, bottom, inboard and outboard as used herein to describe the orientation of the various components are for illustrative purposes only and should not be construed as limiting with respect of the orientation in which the trailing arm may be fitted in a particular vehicle. Similarly, any dimensions are used for illustrative purposes only, and should not be construed as limiting, unless specifically claimed. It should be understood that arms according to the present invention may also be used as leading arms in which the mounting bracket is arranged aft of the air spring on a vehicle.

It will further be appreciated that numerous changes may be made within the scope of the present invention. For example, the trailing arm may be provided with an integral bracket for the fitment of drum rather than disc brakes, or an integral cast drum brake component may be provided on the arm. The arm may be adapted for use with alternatives to air springs, such as coil springs, for example, and may fitted to monocoque-type chassis. Additional features may be cast into the arm such as height control valve mountings and mountings for ABS and other sensors. The arm may be cast from three or more pieces should this be desirable, or if a particular design of arm necessitates further cast pieces. The cast pieces may be secured together by other means such as bolts. The bracket for mounting a brake may be non-cast (e.g. fabricated). The arm may be adapted to receive non-circular (eg square) axles and may mount stub as well as beam axles. The axle wrap portions of the sixth embodiment may be used in conjunction with non-cast or non-forged arms (e.g. fabricated arms). For example, the wraps may be used in the place of those disclosed in the applicant's patent application WO02/20288.